Neutron Scattering Studies of Magnetic Semiconductor Thin Films and Nanostructures

Jacek K. Furdyna, Univ. of Notre Dame, and James J. Rhyne, Univ. of Missouri, DMR-9803218

- A research program with two objectives
  - Development of growth procedures for II-VI magnetic semiconductor nanostructures
  - Fundamental study of the magnetic interactions in these materials utilizing elastic neutron scattering
- New materials and techniques education
  - Involves two graduate students at Notre Dame in Molecular Beam Epitaxy (MBE) growth methods and two at Missouri in Neutron Scattering. Postdocs and visiting scientists also participte.
  - Focused training of scientists in two currently very important fields of materials science.

Members of the Missouri research team in front of the Triple Axis Neutron Spectrometer at the University of Missouri Research Reactor used for this research.

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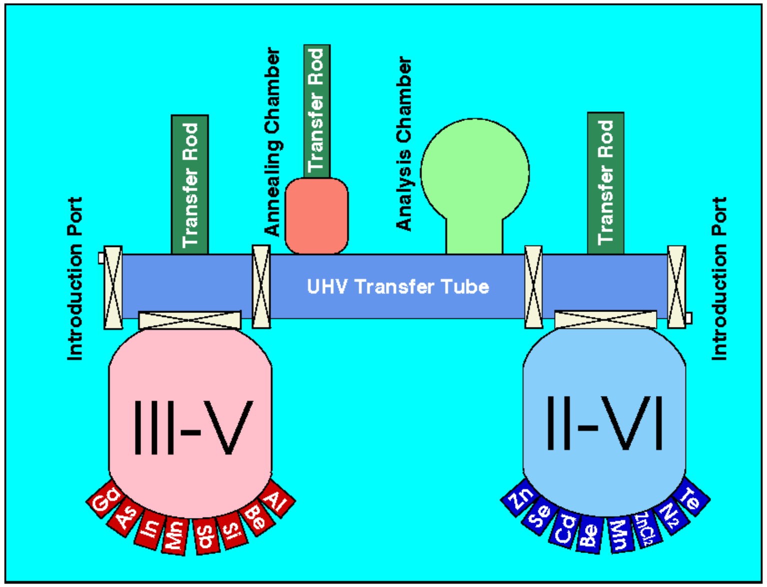
- Molecular Beam Epitaxy (MBE) system capable of growing either II-VI or III-V semiconductor films and superlattices or a combination of both.
- Allows precise control of layer thickness, dopant introduction, and growth rates of superlattice structures



Schematic diagram of MBE facility at Notre Dame with III-V and II-VI semiconductor growth chambers connected by high vacuum transfer tube.

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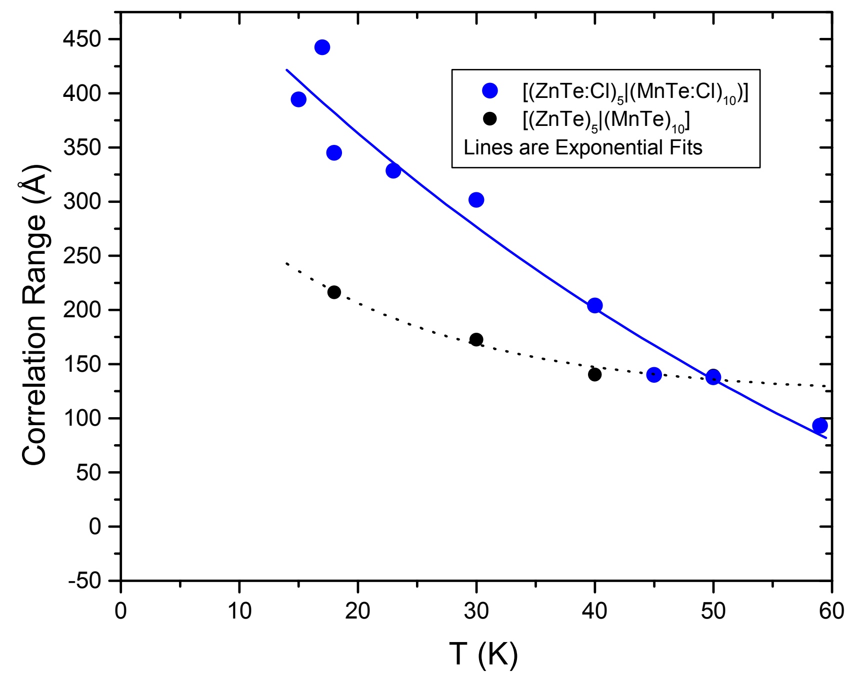
- Neutrons provide a direct measure of range over which magnetic moments are correlated in a superlattice.
- Correlation range is enhanced by over a factor of two by introduction of n-type dopant Cl forming traps in the semiconductor gap.
- Results showed that conventional theories of magnetic superexchange are inadequate to explain the long-range coupling revealed in the superlattice materials. A new mechanism involving electronic properties is required.



Temperature dependence of the magnetic moment correlation range showing enhancement with Cl doping. Ranges are comparable to those observed in **metallic** magnetic superlattices,

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- Distinct “in-phase and “anti-phase” spin structures were observed by neutron scattering from both undoped and Cl-doped magnetic semiconductor superlattices.

- Results show that these two phases exist in discrete non-coherent domains in the superlattices